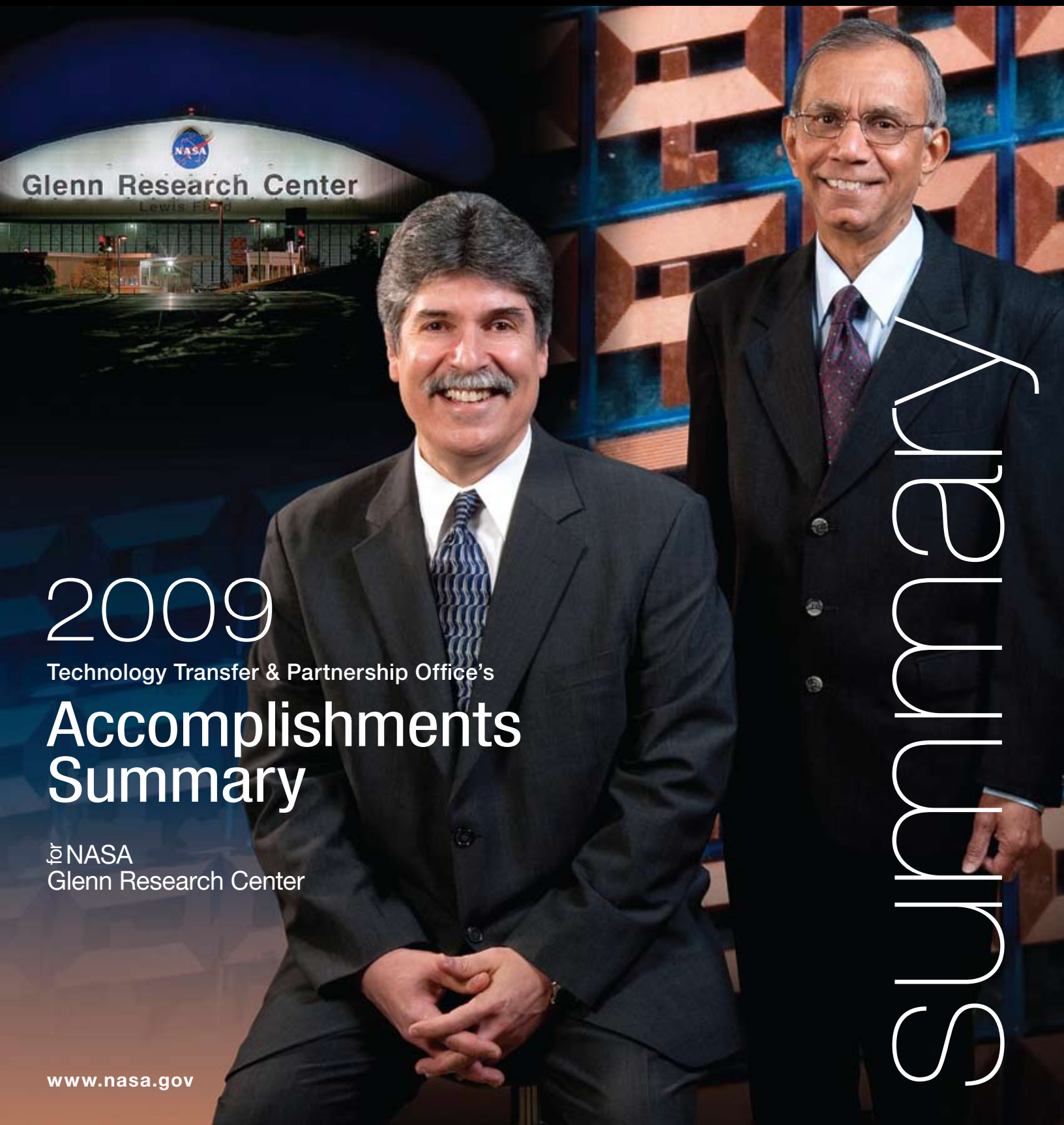
National Aeronautics and Space Administration



2009

Technology Transfer & Partnership Office's

Accomplishments Summary

for NASA
Glenn Research Center

summary

www.nasa.gov

Partnerships Power Progress

Dr. Woodrow J. Whitlow, Jr.
Director

The tremendous talent and capabilities of NASA's Glenn Research Center provide benefits well beyond our physical boundaries—addressing critical needs during natural disasters with our expertise, spurring new products with our innovative research, and forming partnerships with companies to develop products for use by NASA and right here on Earth.

This magazine summarizes three of the latest accomplishments of the Center and illustrates the potential of a renewed NASA technology transfer effort focused on ensuring NASA inventions are made available to the broadest range of U.S. companies, including small businesses. We also highlight our research efforts that have been recognized both inside and outside NASA during this past year to illustrate the scope and depth of our research talent.

I encourage you to visit us at http://technology.grc.nasa.gov to review more of our successes, our technologies, and to explore your opportunities.

Dr. Woodrow Whitlow, Jr.
Director
NASA Glenn Research Center

The NASA's Glenn Technology Transfer & Partnership Office staff.

The Technology Transfer & Partnership Office's (TTPO's) primary purpose is to implement NASA's Innovative Partnerships Program (IPP), including the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Programs, in order to manage Glenn's intellectual property, pursue partnership opportunities, and reward outstanding technical achievements.

On the cover: Drs. Félix Miranda and Rainee Simons are innovators of a wireless radiofrequency telemetry system and biomedical microelectromechanical systems (Bio-MEMS) implantable sensor at NASA's Glenn Research Center. See story on page 4.

Technology Benefiting Disaster Relief Got Its Start at Glenn

An inflatable antenna technology identified by *Inc. Magazine* as one of the "Hottest Products of 2009" got its start at NASA's Glenn Research Center (see Innovator's Insights sidebar) and is enabling faster on-the-ground communications support for disaster relief efforts and military operations. The inflatable antenna from GATR Technologies® provides emergency Internet access, cell coverage, and phone lines over satellite networks via a compact package that can be set up in less than 1 hour.

Prototypes of the ground-based antenna were deployed by GATR to assist with communications needs in Biloxi, Mississippi, following Hurricane Katrina and to support the Federal Emergency Management Agency's efforts following Hurricane Ike. GATR's antenna also has been used to help law enforcement with missing person rescue missions and has provided communications support to the military. Outside the U.S., the antenna has been deployed in Afghanistan, South Africa, South America, Haiti, and Korea. At NASA, GATR's antenna is being considered for a possible lunar ground station as well as the next-generation NASA Communication Architecture.

GATR antenna currently deployed on a rooftop in Afghanistan.

Because the antenna system is compact and can be set up in about one hour, GATR personnel were recently able to provide swift communications assistance to Haiti in response to the January 2010 earthquake. The company deployed units at key locations to support search-and-rescue missions, special operations, and local hospitals. The antennas provided Internet access to first responders and doctors through a coordinated effort with Cisco Systems® Inc., and satellite provider Intelsat General Corporation.

GATR provided high-bandwidth communications to disaster relief groups well before traditional satellite communication equipment arrived in Haiti.

Providing high-speed Internet and phone access satellite links to medical staff and citizens, the GATR antenna supports the U.S. Navy Ship Comfort Mission, a floating hospital, throughout several ports of call in South America.

Innovator's Insights

The Small Business Innovation Research (SBIR) Program offers great opportunities to help companies build new product lines—but it takes perseverance and an eye on long-term relationships by each company and NASA. For example, this antenna technology began with a 1998 Glenn SBIR Phase 1 contract with SRS Technologies, Inc., to develop solar concentrators for power generation. This connection with NASA led to the company requesting NASA's assistance in solving issues they had encountered with an inflatable antenna technology they were developing for the military. SRS became ManTech, then Nexolve, and then formed GATR Technologies in 2004 to license its technologies. A subsequent award from the Department of Defense to GATR led to the development of an inflatable antenna system that GATR patented.

NASA provided assistance under a Space Act Agreement and continues to work with GATR, characterizing three 1.8- to 5-meter-class, inflatable radome antenna systems, developing antenna feeds, and conducting surface mapping and characterization of antenna patterns. The antenna has potential applications in a planned lunar ground station and in future Earth science monitoring.

—Dr. Robert Romanofsky, Innovator, NASA Glenn Research Center

Innovator's Insights

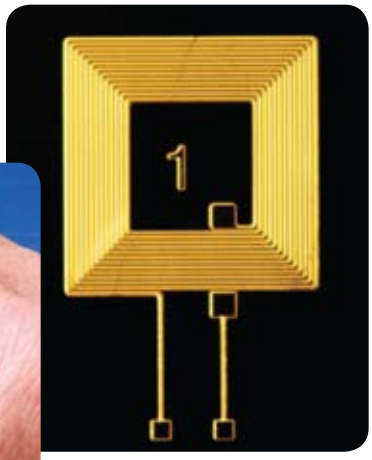
In 2002, the TTPO initiated a program to apply NASA technologies to biomedical problems. It provided the resources necessary to adopt the RF technology that had been created for the NASA communications program to the development of novel miniature conformal antennas and signal processing circuits for use in Bio-MEMS sensors and actuators.

After the technology came to the attention of Dr. Anthony Nunez, now a cardiothoracic surgeon at the Cleveland Clinic Foundation, the TTPO helped negotiate a Space Act Agreement and execute the license for two Bio-MEMS sensor and actuator patents. Glenn's TTPO has continued to support recognition of this technology within and outside of NASA.

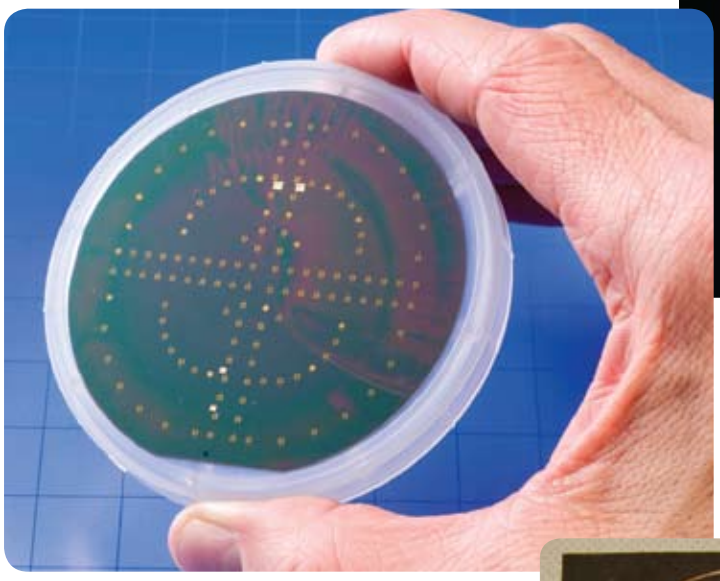
—Drs. Félix Miranda and Rainee Simons, Innovators, NASA Glenn Research Center

New Measurement of Blood Pressure May Help Thousands

Start-up company Endotronix is developing a new radiofrequency (RF) biomedical microelectromechanical systems (Bio-MEMS) sensor technology, capable of helping thousands of people avoid the potentially life-threatening complications of hypertension, abdominal aortic aneurysms, and congestive heart failure. Early animal trials of implanted blood pressure sensors, developed by Endotronix and based on Glenn technology, have successfully yielded accurate wireless measurements of blood pressure at several implant sites.



Bio-MEMS miniature (1- by 1-mm) inductor/antenna for exceptional signal strength.



Semiconductor wafer with step and repeated miniature inductor/antenna circuits.

Multiturn loop antenna for inductive powering and telemetry from Bio-MEMS sensor.

"We have worked on this collaboration and several others with the assistance of the TTPO, and we have found its staff to be knowledgeable, helpful, and critical to our commercialization success."

—Drs. Félix Miranda and Rainee Simons, Innovators, NASA Glenn Research Center

Dr. Félix Miranda (background) focuses the microscope on a miniature inductor/antenna while Dr. Rainee Simons (foreground) examines the image on the screen.

The Perfect Fit

According to Dr. Harry Rowland, Vice President of Engineering at Endotronix, the primary benefit of the wireless sensor is that it can be used continually. Furthermore, this sensor is of particular help when a patient is transferred out of a hospital's intensive care center to a step-down unit. For example, physicians can continue to chart the effects that an oral medication is having on blood pressure control to better customize treatment.

"We were impressed by the large transmission distance and very small sensor size of this technology. The biggest challenge with these kinds of sensors is to get the signal out of the body, using a small sensor that doesn't damage surrounding tissue."

—Dr. Harry Rowland, Vice President of Engineering, Endotronix

The Technology

The technology involves a wireless RF telemetry system that includes a Bio-MEMS implantable sensor and an external hand-held unit. A MEMS capacitive pressure sensor, integrated with a miniature inductor/antenna, makes up the implantable sensor. Signal processing circuits and a printed loop antenna form the cell-phone-sized, hand-held unit that inductively powers and also receives telemetry signals from the sensor.

At 1 mm long by 1 mm wide and 0.5 mm thick, the implanted sensor is significantly smaller than any comparable item currently available. Because it is powered by the external hand-held unit, the sensor has no need for implanted batteries, reducing the possibility of infections. The system operates only when interrogated by the external hand-held unit, so power dissipation is minimized and the chance of overheating biological tissue in the vicinity of the sensor is greatly reduced. Also, the sensor can communicate with the external unit at more than three times the distance of any comparable systems.

Innovator's Insights

The TTPO invested funding to grow this research effort from reproducing the original Apollo lunar tires for study to building the next generation of tires to handle the increased load and life required for future lunar missions. The resulting design has applications in a variety of off-road environments, from military use in the desert to all-terrain vehicles for sport and rescue.

The TTPO's efforts have been crucial in attracting international attention to the potential benefits of the Spring Tire on Earth.

—Vivake Asnani, Surface Mobility Technology Team Leader, NASA Glenn Research Center

"...all of the energy used to deform the tire is returned when the springs rebound; it doesn't heat up and waste energy like a normal tire."

—Jim Benzing, Principal Engineer, The Goodyear Tire & Rubber Company

An Energy-Efficient Tire That Will Never Go Flat

Goodyear and NASA Invent the "Spring Tire" for the Moon and Possibly Earth

The Spring Tire is intended to operate reliably in extreme environments, such as on the Moon.

Over the past year and a half, Glenn researchers and The Goodyear Tire & Rubber Company have worked together, supported by the IPP Seed Fund in developing an airless tire to transport large, long-distance vehicles across the surface of the Moon. Their new patent-pending "Spring Tire" is designed to carry much heavier vehicles over much greater distances than the wire mesh Moon tire originally developed for the Apollo Lunar Roving Vehicle, and one day this technology may be used for vehicles here on Earth as well.

The original Moon tire was developed because pneumatic (air-filled) tires used on Earth would function poorly on the Moon, reacting to the negative effects of the Moon's extreme cold and hot temperatures on rubber. Additionally, unfiltered solar radiation degrades rubber, and pneumatic tires would pose an unacceptable risk of deflation.

A Simple Network of Springs

According to NASA's principal investigator Vivake Asnani, a significant change in requirements from the original mesh Moon tire generated the need for considerable innovation. "With the combined requirements of increased load and life, we needed to make a fundamental change to the original Moon tire. What the Goodyear-NASA team developed is an innovative, yet simple network of springs that does the job. The resulting tire design seems almost obvious in retrospect, as most good inventions do," said Asnani.

He further commented that the Spring Tire does not have a single point failure mode. "A hard impact that might cause a pneumatic tire to puncture and deflate only would damage one of 800 load-bearing springs. In addition to having this ultra-redundant characteristic, the new tire has a combination of overall stiffness yet flexibility that allows off-road vehicles to travel fast over rough terrain with relatively little motion transferred to the vehicle," Asnani explained.

Who Knew Tires Could Be More Energy Efficient?

At the spot where rubber tires meet the road, the rubber bends, which expends energy, but when the rubber returns to its original shape, it does not return all of the energy. Instead, some of that energy is converted to heat by the friction and work of bending. The Spring Tire, as noted by Jim Benzing, Goodyear's lead innovator on the project, "…is durable and extremely energy efficient. The spring design contours to the surface on which it's driven, providing traction. But all of the energy used to deform the tire is returned when the springs rebound; it doesn't heat up and waste energy like a normal tire."

The Spring Tire was installed on NASA's Lunar Electric Rover and put through its paces at Johnson Space Center's "Rock Yard" in Houston, where it performed successfully.

2009 Awards: Innovations That Are Powering Progress

NASA Awards

NASA's Inventions and Contributions Board (ICB) Exceptional Space Act Awards recognize the most significant scientific and technical contributions to the Agency. Glenn's winners in 2009 were

- **Intrinsically Safe Fiber Optic Gas Vapor Sensor for Aircraft Fuel Tank Fire Safety** *(Glenn Invention of the Year Nominee)*
- **Nondestructive Evaluation (NDE) Wave and Image Processor Software** *(Glenn Software of the Year Nominee)*
- **vMetrics: A Compact, Wireless, Highly Configurable, Biometric Real-Time Monitoring System**

External Awards

Our technologies have received recognition of excellence by many external organizations including

- *R&D Magazine* presents the **R&D 100 Award** to the top 100 most technologically significant products of the year. Glenn's 2009 winning technologies were the
  - **Optimal Trajectories by Implicit Simulation version 4 (OTIS4)**
  - **NASA Mini-Classifier, a Microscale Particulate Classifier**
  - **L-3 ETI Model 2300HE High Efficiency Space Traveling-Wave Tube Amplifier for NASA's Lunar Reconnaissance Orbiter Spacecraft**
- The annual **Northeast Ohio Technology Coalition Innovation Awards** program honors the achievements of companies, entrepreneurs, universities, and nonprofit organizations throughout northeast Ohio that have developed technologies that are impacting our everyday lives. Glenn's **BioWATCH** technology, which will monitor astronaut health while in space, was one of eight winners.
- The **Northeast Ohio Software Association Best of Tech Awards** recognizes outstanding companies and impressive tech entrepreneurs. In 2009, Glenn's **Optimal Trajectories by Implicit Simulation version 4 (OTIS4)** was awarded Best Software Product.
- The **Federal Laboratory Consortium (FLC) Award for Excellence in Technology Transfer** recognizes science and technology employees in FLC laboratories who have accomplished outstanding work in the process of transferring Federally developed technology. Glenn winners included
  - **Metallic Foam to Reduce Turbofan Engine Noise** *(FLC Midwest Regional Excellence in Technology Transfer Award)*
  - **Atomic Oxygen—Textured Surfaces for Blood Glucose Monitoring** *(FLC National Excellence in Technology Transfer Award)*
- Selected as a runner-up in the wireless category in the **2009 Wall Street Journal Technology Innovation Awards** competition was the **Miniature Implantable RF System for Real-Time Telemetry from MEMS-Based Sensors and Actuators**.

The Invention and Contributions Board Awards recognized 181 Glenn inventors in 2009 with awards totaling $221,675.

Those awards included

- 16 Space Act Awards
- 3 Exceptional Space Act Awards
- 44 Tech Brief articles
- 6 software releases
- 7 patent applications

Dr. Quang-Viet Nguyen receiving an Exceptional Space Act Award from Dr. Mary Ann Meador, Glenn representative to the ICB.

l-r: Dr. J. Scott Deiter (FLC Chair), Bruce Banks, Laurie Stauber, John Emond (NASA Headquarters), Debbie Waters, Susan Sprake (Vice Chair, FLC) at the May 2009 FLC National Meeting/Awards Ceremony in Charlotte, NC.

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